

# SELF-VENTILATING DISC BRAKE ROTOR

## FIELD OF THE INVENTION

5

This invention relates to brake apparatus. More particularly although not exclusively it discloses an improved rotor for vehicle disc brakes.

10

## BACKGROUND OF THE INVENTION

Existing disc brake rotors typically comprise a central hub or hat co-axial with a surrounding ring and a brake band adapted for frictional contact with brake pads on each side.

15

With self-ventilating disc brakes there are two spaced apart parallel rings and bands provided on each rotor which are cooled by a radial flow of air outwardly through channels formed between them. This flow largely results from centrifugal forces generated by rotation of the rotor.

20

Prior art rotors have generally attempted to arrange pillars and other internal supporting structures so as to make their induction of flow dependent on the direction of rotation of the rotor when in use so that separate rotor castings are required for the right and left hand sides of a

25

vehicle. Where symmetrical patterns of supporting pillars or structures have been employed, little attention has been given to the provision of channeling formations within the pattern. The result is a tendency to excessive temperature generation during severe braking which can cause swelling,

cracking and stress fatigue in the rotor disc.

It is an object of at least preferred embodiments of the present invention to address or ameliorate the above mentioned disadvantages or at least provide a useful alternative.

#### **SUMMARY OF THE INVENTION**

*Refer to Claims*

10

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

The currently preferred embodiment of the invention will now be described with reference to the attached drawings in which:

Figure 1 is a perspective view of a brake rotor from the outboard side.

20 Figure 2 is a perspective view of the rotor from the opposite inboard side.

Figure 3 is a cross-sectional view of the rotor along the lines A-A of figure 1 showing the preferred form of the vent ports.

25 Figure 4 is an elevation view of the outboard side of the rotor.

Figure 5 is a detailed view showing the preferred cross-sectional shape and arrangement for the pillars.

Figure 6 is a further detail of a portion of a cross-section indicating repeating patterns of pillar clusters.

Figure 7 is a further view of the portion of the cross section of figure 6 indicating air flow patterns.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

##### 10 First Embodiment

Referring first to figures 1 to 3 there is a brake rotor comprising a central hub or hat 1 for mounting a vehicle wheel by means of bolts passing through apertures 15 1A. Surrounding the hat and co-axial with it are rings 2 which form brake bands 3 on the inboard and outboard sides for engagement with brake pads (not shown) . The rings 2 are supported in a spaced apart parallel configuration by pillars with radial ventilation channels formed between them 20 as described in more detail later. In accordance with a preferred embodiment of the invention the sides 4 of the hat or hub are inclined outwardly at about 4 degrees as best shown in figure 3. The outer periphery of the hat leads into a deep heat dam 5. This construction closely aligns the web 25 6 with the centre-line 2A of the rotor rings 2 to reduce vibration, better defines a heat distortion point for the rotor and also facilitates a smooth flow of air into the outboard vent ports 7. These ports 7 receive a flow of

cooling air unobstructed by the front wheel assembly and splash plate. They are preferably rectangular in shape and are set into the outer face **5A** of the heat dam in order to pick up the air flow along inclined sides of the hat (see  
5 arrow A in figure 3). The vent outboard wall **7A** preferably has a large radius surface (e.g about 20 mm) to minimise flow friction by smoothly merging into the ventilation channels between the pillars. Also shown in figures 2 and 3 are vent ports **8** leading into the ventilation channels from  
10 the inboard side of the rotor. These ports **8** are distributed around the inner periphery of the rings **2**. The port walls are defined by a contoured inlet horn **BA** formed by the inboard face of the tapered hat sides **4**. The opposite port walls **3D** are formed by the inner periphery of the rings  
15 **2**. They are also contoured to lead smoothly into the ventilation channels. To assist the radial inflow of air into the ports **8** the wall **3D** preferably extends out further from the rotor centre line **2A** than the opposite horn **BA**.

#### **Second Embodiment**

20 A preferred arrangement of the support pillars between the rings is shown in figures 4 and 5. With this embodiment the pillars are disposed in repeating clusters of six units as indicated by broken line **9**. Each cluster by means of the overlapping edges **10** and the elongated triangular shape of  
25 the pillars **11** defines radial air flow channels **12** out between the rings in accordance with the direction of

rotation. There are also inner pillars 14 which are preferably triangular or bell shaped in cross-section so that the curved edges 15 act as air scoops to draw air in through the vent ports 8 and 9. Alternating with these  
5 pillars 14 are elongated diamond shaped pillars 16 which are asymmetrical in the radial direction so that the widest point 17 is offset toward the centre of the rotor. This shape has been found to better deflect and draw the air from the vent ports into the channels.

10 As the layout of each pillar cluster is preferably symmetrical with respect to the two opposite rotational directions dedicated left and right rotors are unnecessary with this embodiment. The air flow passes equally through either of the channels 12 in accordance with the direction  
15 of rotation.

The bases of the pillars are preferably radiused at 18 to prevent stress concentrations. Strengthening ribs 19 have also been formed on the web between the outboard ports to prevent cracking.

20 With further reference to figs 4 and 5 there is disclosed a disc brake rotor having a central hub coaxial with and supporting annular rings which form an inboard brake disc and an outboard brake disc for engagement with brake pads, the inboard disc and the outboard disc  
25 maintained in a parallel spaced apart configuration by pillars with channels defined between the pillars whereby in

use of the rotor air is drawn in through vent means and then radially outwardly through the channels as the rotor turns, the pillars arranged in repeating clusters of six with each cluster in cross section including radially aligned inner  
5 and outer pillars with pairs of radially aligned intermediate pillars positioned symmetrically one pair on each side of a radially aligned central axis defined by the radially aligned inner and outer pillars; each pair of the pairs of radially aligned intermediate pillars defining a  
10 channel between the pillars comprising the pair; the channel offset from a radially aligned direction.

Each cluster of six pillars may be defined in a first grouping **20** as shown by the dashed outlines of figure 6. The repeating clusters of six pillars of the presently described  
15 grouping are circumferentially disposed at 20 degree angular separation, so that there are 18 such clusters in total.

In this grouping the radially aligned inner and outer pillars are comprised of an inner pillar **21** of generally oviform or diamond cross sectional shape and an outer pillar  
20 **22** in cross section shaped somewhat like an isosceles triangle with, in at least one preferred embodiment, a rounded base. The height of the isosceles triangle is significantly greater than the base and lies along the central axis **23** of the cluster. Similarly the long axis of  
25 the oviform or diamond shaped inner pillar also lies along the central axis **23**.

The pairs of radially aligned intermediate pillars 24 lying to the right of the central axis 23, and the corresponding pair of intermediate pillars 25 on the left form a herringbone pattern, each pair defining a narrow  
5 channel 26 and 27 respectively (as indicated on the enlargement of figure 6).

These intermediate pairs of pillars perform important structural functions in preventing mechanical distortion in this median area of the inboard and outboard discs during  
10 heavy braking. At the same time the heat generated through the braking action will tend to induce thermal distortion. Thus it is highly desirable to combine a maximum cross sectional area of mechanical support with the best possible ventilation in this intermediate area. The configuration of  
15 the intermediate pillar pairs of the present invention achieves this by providing the narrow, angled air flow channels 26 and 27 between the pairs, thus combining the required large cross sectional area with adequate air flow.

The actual pattern of air flow and the velocity of air  
20 through the pattern of six pillars is a function of both rotational direction and the angular velocity of the rotation. The pattern of air flow for an anti-clockwise rotating disc is shown in figure 7. Thus in the anti-clockwise spinning disc of figure 7 strong air flow is  
25 induced through channel 27 with little if any through channel 26. Nevertheless, as has been indicated by computer

analysis and in use measurements, the air flow created through the one pair of pillars provides excellent heat dissipation for each of the 18 clusters. Clearly, by virtue of the symmetry of the six pillar pattern the air flow is  
5 mirror reversed for clockwise rotation. Thus the same discs may be mounted to either side of a vehicle.

As can again be seen in figure 6 the adjoining clusters of the present grouping are separated by a pair of radially aligned inner and outer pillars 30 and 31 respectively. The  
10 outer pillar 31 is identical to the outer pillar 22 defining the central axis of the cluster but the inner pillar 30 is of a different bell-shaped form having concave side edges 32. These inner pillar concave edges act as blades or impellers to accelerate and direct air flow into the  
15 cluster.

A second grouping 40 of six pillars to form each cluster may be chosen using the radial line defined by the inner and outer pillars 30 and 31 separating the first described clusters as a new central axis with, in this  
20 grouping the inner pillars alternating between the ovoid or diamond shape pillars 21 and the bell shaped pillars 30. These clusters then have an angular separation of 10 degrees as shown in figure 6, adjoining clusters overlapping so as to share either radially aligned intermediate pairs of  
25 pillars 24 or 25 alternately.

The optimization of air flow was firstly derived



through computer modeling of the pillar cluster to arrive at the present pattern. However to realize this complicated pattern, and particularly that of the desired narrow channel between the pairs of radially aligned intermediate pillars  
5 in a production process proved very difficult.

The casting of the discs and pillars is effected using a pre-moulded sand core. This is a negative of the final product and is produced by the injection of a sand mixture and bonding agent into a cavity die. The production of the  
10 core forming die in itself provided considerable machining difficulties. In addition it was found that special provisions had to be made in the die to allow for the elimination of air traps in the fine interstices within the cluster formations. Normally, casting of the rotor is  
15 effected by introducing the molten metal from points around the periphery of the sand core but this method could not provide adequate filling of the pillar structures and casting had to be by introduction of the metal via a spider feeding the internal periphery of the hat structure.

20 The above describes only some embodiments of the present invention and modifications obvious to those skilled in the art can be made thereto without departing from the scope and spirit of the present invention.

For example the design of the hat and brake bands as  
25 well as the shape and configuration of the vent ports and pillars may be changed according to application. Also while

the rotor is preferably cast using G220 grey iron the invention extends to the use of any other suitable material.